§5. Construction of Supporting Structure for Coils

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The superconducting coils in the LHD are supported by a torus-shaped structure called the supporting structure for the electromagnetic forces. The major radius, minor radius and maximum diameter of this structure are 3.9 m, 1.85 m and 12m, respectively. The lower part of this structure was built as a part of the lower cryostat that was already completed in FY1994. Since FY1996, construction of the upper cryostat has started and the upper part of the supporting structure has been built and connected together with the lower one. It is made of 100-mm-thick type 316 stainless steel. Contents of Carbon and Nitrogen were controlled in this stainless steel to increase strength at low temperature and to be easy welding. The weight of this structure after assembly is about 400 tons. This structure will be cooled down with the coils to liquid helium temperature. The total mass that will be cooled is 850 tons including the magnets and ten legs that maintain an adiabatic condition will support this weight. Overall accuracy of 5 mm was required to the supporting structure during construction because the superconducting helical coil and the poloidal coils were going to set into/onto this structure.

The supporting structure for the electromagnetic forces has been assembled in the LHD hall because transportation in its final form is impossible. The 20 sections, built by the manufacturer, are 36 degree fan-shaped pieces, assembled into upper and lower hemispheres. Fig. 1 shows the flowchart of the construction process for the supporting structure. During the process of on site welding for ten sections of the hemisphere, the average deformation was less than 4 mm. The deformation during the welding of the upper supporting structure showed a good symmetrical correlation with the lower one. After the completion of the lower and upper parts, they were welded together at the equator, holding the helical coils in the torus shell and simultaneously shell arms that are attached to the coil covers of the helical coils were connected to the inside of the supporting structure by welding. Total deformation by this process was below 5 mm, which allowed us to achieve the required overall accuracy.

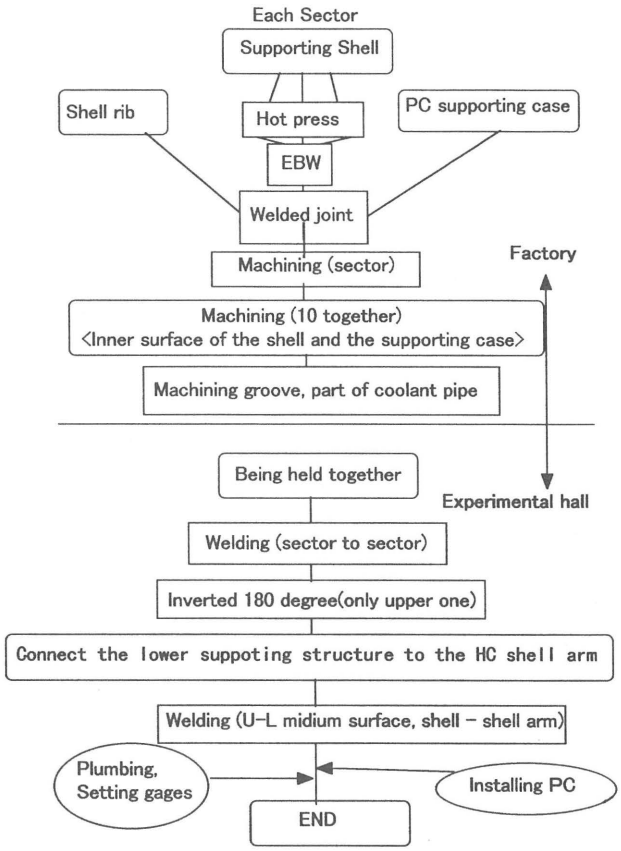

Fig. 1. Flowchart of construction process for the supporting structure.

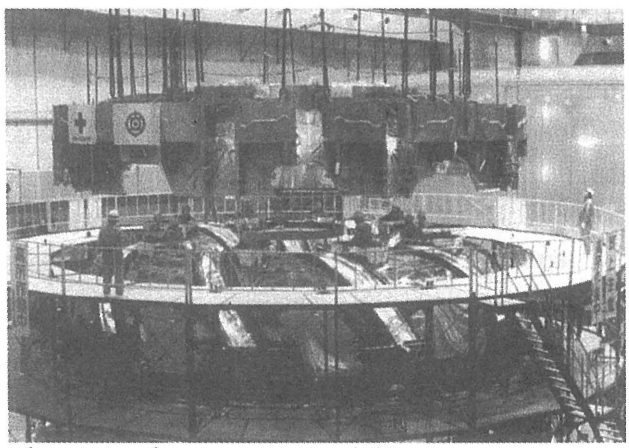

Photo. 1. The upper part of the supporting structure was moved to the position where the lower one and the coils were set.